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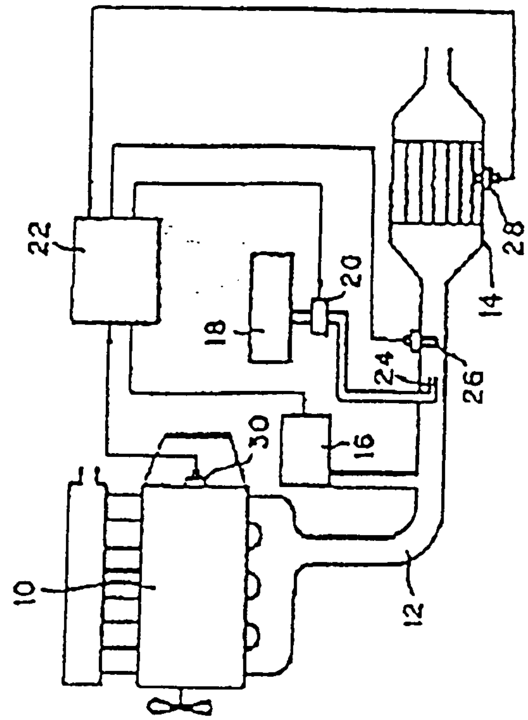
TITLE : EXHAUST GAS PURIFIER FOR INERNAL COMBUSTION ENGINE



ABSTRACT : PURPOSE:To provide an exhaust gas purifying effect as early a possible by burning combustible components such as HC in the exhaust gas completely, and warming the catalytic converter promptly during the time from temperature rising of a catalyt converter to its activation.
CONSTITUTION:This exhaust gas purifier is provided with a hydrogen generation means 18 which generates hydrogen to be f in an exhaust passage 12 on the upstream side of an internal combustion engine 10, a hydrogen feed means 20 which communic the hydrogen generation means 18 with a hydrogen in-flow oper 24 in the exhaust passage 12, an air feed means 16 which feec additional air around the hydrogen in-flow opening 24, an ignition means 26 which is provided around the hydrogen in-fl opening 24 for igniting hydrogen which is fed to the inside c the exhaust passage 12, and a control means 22 which operates respective means when catalyst temperature of a catalytic converter 14 is less than a prescribed value.

30 - H_2O Temp. Sensor.
28 - Cat. Temp. Sensor.

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KOKAI PATENT APPLICATION
NO. HEI 4[1992]-318214

DEVICE FOR PURIFYING EXHAUST GAS FROM INTERNAL COMBUSTION ENGINES

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DEVICE FOR PURIFYING EXHAUST GAS FROM INTERNAL COMBUSTION ENGINES

[Nenen Kikan No Haiki Joka Sochi]

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[There are no amendments to this patent.]

Claim

A device for purifying exhaust gas from internal combustion engines characterized by the fact that it is equipped with a hydrogen generation means that is installed in an internal combustion engine (having a catalyst converter) in an exhaust passage to purify exhaust gas and generate hydrogen to supply to the exhaust passage upstream of the above mentioned catalyst converter, a hydrogen supply means that connects the above mentioned hydrogen generation means and an inflow opening for the hydrogen installed in the above mentioned exhaust passage, an air supply means that supplies additional air in the vicinity of the inflow opening of the above mentioned hydrogen into the above mentioned exhaust passage, an ignition means that is installed in the vicinity of the inflow opening of the above mentioned hydrogen to ignite the hydrogen being supplied into the above mentioned exhaust passage, and a control means that operates the above mentioned means when the catalyst temperature of the above mentioned catalyst converter is a prescribed value or lower.

Detailed explanation of the invention

[0001]

Industrial application field

The present invention pertains to a device for purifying an exhaust gas from internal combustion engine and in particular, pertains to an improvement in the start characteristics in a

device for purifying exhaust gas having a catalyst converter in an exhaust passage.

[0002]

Prior art

In general, a catalyst converter such as a ternary catalyst being used as a device for purifying exhaust gas from internal combustion engines has a low temperature for a while after the start and is not activated. It cannot sufficiently exert the exhaust gas purifying action and hydrocarbons (HC) and other harmful substances in the exhaust gas are discharged in an untreated state into the air. Since it can result in air pollution, certain countermeasures are required. In a conventional technique described in Japanese Kokai Utility Model No. Sho 47[1972]-3110, an ignition plug is installed in an exhaust pipe of an internal combustion engine, and the exhaust gas is reignited by operating the ignition plug during low temperatures, so that the exhaust gas is reburned. A thermal reactor is heated by the reburning, so that the temperature is rapidly raised to the reaction temperature.

[0003]

Problem to be solved by the invention

Since exhaust gas is a gas whose combustion is completed in a combustion chamber of an internal combustion engine, even it includes an unburned portion, the concentration of unburned

portions with respect to the nonflammable portion such as nitrogen, carbon dioxide, and water is not high. Thus, it is a gas that is very difficult to ignite, and it is not simply ignited even by the discharge of an ignition plug. Therefore, in the above mentioned conventional technique, there is no guarantee that the exhaust gas can be reliably reignited every time, and recombustion of the exhaust gas is often incomplete. Thus, unburned HC, etc., are discharged in an untreated state into the air. It cannot be considered that the purpose of the above mentioned conventional technique, in which the temperature is rapidly raised by heating the thermal reactor by recombustion heat from the exhaust gas, can be sufficiently achieved.

[0004]

The present invention solves problems of the conventional technique. Its purpose is to provide an effective means that reliably ignites inflammable portions such as HC by a means other than a catalyst converter while the temperature of the catalyst converter is being raised and activated, hinders nonflammable portions from being discharged as is into the air, and rapidly warms up the catalyst converter to offer an exhaust gas purifying action as soon as possible.

[0005]

Means to solve the problem

In order to solve the above mentioned problems, the present invention provides a device for purifying exhaust gas of an internal combustion engine characterized by the fact that it is equipped with a hydrogen generation means that is installed in an internal combustion engine (having a catalyst converter) in an exhaust passage to purify exhaust gas and generate hydrogen to supply to the exhaust passage upstream of the above mentioned catalyst converter, a hydrogen supply means that connects the above mentioned hydrogen generation means and an inflow opening for the hydrogen installed in the above mentioned exhaust passage, an air supply means that supplies additional air in the vicinity of the inflow opening of the above mentioned hydrogen into the above mentioned exhaust passage, an ignition means that is installed in the vicinity of the inflow opening of the above mentioned hydrogen to ignite to the hydrogen being supplied into the above mentioned exhaust passage, and a control means that operates the above mentioned means when the catalyst temperature of the above mentioned catalyst converter is a prescribed value or lower.

[0006]

Function

When the catalyst converter is at low temperature as during the starting of an internal combustion engine, the catalyst is

not activated and there is no ability to purify contaminants in the exhaust gas. However, at that time, an appropriate amount of hydrogen can be sent to an hydrogen inflow opening to the exhaust passage through a hydrogen supply means from the a generation means by a control means and discharged into the exhaust passage. The hydrogen can be mixed with air introduced into the exhaust passage by an air supply means and forcibly ignited by an ignition means, so that reliable ignition and combustion is realized. Thereby, the temperature of the surrounding exhaust gas can be raised, and the unburned portions in the exhaust gas can be ignited and burned, so that contaminants such as HC are eliminated.

[0007]

Furthermore, the catalyst can be rapidly heated by introducing hydrogen and combustion gases in the exhaust gas (whose temperature is raised by burning in the exhaust passage) into the catalyst converter. The catalyst temperature is raised and it is activated quickly. Thereby, since the catalyst purifies contaminants, the harmful contaminants are not discharged initially after the start of the internal combustion engine.

[0008]

Application example

Figure 1 shows a system constitution of an application example of the present invention. Catalyst converter 14 is connected to exhaust passage 12 of internal combustion engine 10,

and at the upstream side, for example, air from an air supplier 16 such as an electromotive air pump is supplied. At the same time, from hydrogen generator 18 such as a water electrolyzer, an appropriate amount of hydrogen is supplied at an appropriate time via control valve 20 such as an electromagnetic valve. Control valve 20, for example, is controlled (opened and closed) by a control signal from a electronic control unit (ECU) 22. At the downstream of spray nozzle 24 for the hydrogen being supplied into exhaust passage 12, an ignition plug 26 such as a spark ignition plug or glow plug is installed and is electrically activated by a control signal from ECU 22 so that when hydrogen is sprayed from nozzle 24 ignition plug 26 ignites. Output signals from catalyst temperature sensor 28 for detecting the temperature of the catalyst bed of catalyst converter 14, water temperature sensor 30 for detecting the coolant temperature of internal combustion engine 10, etc., are input into ECU 22, and calculation results are outputted as control signals to control valve 20 for hydrogen, air supplier 16, ignition plug 26, etc., as mentioned above, based on measurements.

[0009]

A detailed control example of control valve 20, air supplier 16, and ignition plug 26 (for hydrogen) by ECU 22 is explained. Flow chart of Figure 2 specifically shows routine program 100 in the case where the internal combustion engine is controlled by the catalyst bed temperature. Figure 3 shows routine program 200 for setting initial values in program 100 when the control of internal combustion engine 100 is started. When the operation and control of the internal combustion engine 10 is started, the

routine program 200 for initialization of Figure 3 is implemented, and as will be mentioned later, the value of flag H_2airflag (which is an index showing whether or not hydrogen and air supplied into the exhaust passage 12, are set to 0 at step 201), control valve 20 for supplying hydrogen at step 202, air supplier 16 for supplying air at step 203, and ignition plug 26 for reignition at step 204 are set to the initial states of the control by being respectively blocked by being given an OFF control signal from ECU 22. Then, catalyst warming-up machine routine program 100 of Figure 2 is repeatedly implemented in an interruption mode in a main program of operation and control of internal combustion engine 10 at a short time interval such as the ratio of once per one rotation of internal combustion engine 10.

[0010]

The catalyst warming-up routine program 100 shown in Figure 2 is started, first, whether or not the internal combustion engine 10 is started is detected at step 101. The "start state" is detected by whether or not a starter switch, which is not shown in the figure, for starting the internal combustion engine, is ON, that is, whether or not the starter motor is electrified. However, if the starter switch is turned ON and then turned OFF, the engine may be regarded as in the "start state" until the number of rotations of internal combustion engine 10 reaches a prescribed value.

[0011]

If the internal combustion engine is in the "start state," flow proceeds to step 102, and whether or not hydrogen and air are currently supplied into the exhaust passage 12 at the upstream of catalyst converter 14 is determined from the value of flag H_2airflag. In the supply state of hydrogen and air in which the value of the flag H_2airflag is 1, the routine is ended. However, when the value of the flag H_2airflag is 0, that is, hydrogen and air are not supplied into exhaust passage 12, flow proceeds to the step 103, and whether or not the signal of catalyst bed temperature (may also be water temperature of the engine being detected by temperature sensor 30) being detected by temperature sensor 28 is larger than a prescribed value, CT, is determined. When the temperature is higher than CT, catalyst converter 14 has already been warmed up, and since it itself has sufficient exhaust gas purifying ability, a special means is not required. Thus, the routine is immediately ended. At step 103, when the catalyst bed temperature is not larger than prescribed value CT, contaminants such as HC in the exhaust gas are discharged into the air through the catalyst converter 14, and a certain countermeasures are required.

[0012]

According to the characteristics of the present invention, at step 104, a control signal for electrically activating ignition plug 26 is emitted from ECU 22, and a spark discharge of ignition plug 26 is started, or it is heated to redness by electrification of the glow plug. At step 105, air supplier 16 is driven by a control signal from ECU 22, and fresh air is introduced into air passage 12. At step 106, ECU 22 emits a

control signal for opening valve 20, and hydrogen from hydrogen supplier 18 onto ignition plug 26 in exhaust passage 12. The hydrogen sprayed from nozzle 24 is mixed with air from air supplier 16, easily ignited by ignition plug 26, and burned in exhaust passage 12 upstream of catalyst converter 14, so that the temperature of the surrounding exhaust gas is markedly raised. Thus, inflammable portions such as HC in the exhaust gas, which are difficult to ignite, are also ignited, so that the recombustion of the exhaust gas is started. Then, at step 107, the flag H_2airflag, which is an index of the hydrogen spray and reignition implementation, is set to 1, and the routine is ended. Thus, the recombustion state of the exhaust gas is established in exhaust passage 12 at the upstream of catalyst converter 14 in a short time, and unburned portions, such as HC, of the exhaust gas are burned, so that the exhaust gas is purified.

[0013]

When the decision result of step 101 is not the "start state" since the starter switch, which is not shown in the figure, is turned OFF and the number of rotation of the internal combustion engine 10 is at a prescribed value, flow proceeds to step 108, and whether or not flag H_2airflag is 1 is determined. When flag H_2airflag is 1, flow proceeds to step 109, and whether or not the lapsed time after the start of the internal combustion engine exceeds a prescribed value T_1 is determined. When the time exceeds the prescribed value T_1, ECU 22 emits a control signal for closing control valve 20 at step 110, and spraying of the hydrogen from the nozzle 24 is stopped. Furthermore, at step 111, the electric ignition of ignition plug 26 is also stopped.

However, since the temperature in exhaust passage 12 has already been raised and the recombustion of the exhaust gas is established, combustion is not immediately stopped by the stop in supply of hydrogen or the stop of ignition.

[0014]

In Figure 2, whether or not the lapsed time after the start of the internal combustion engine exceeds a second prescribed value T_2 is determined. When the time exceeds the prescribed time T_2, since catalyst converter 14 is heated by the hydrogen burned in exhaust passage 12 and the heat of the reburned exhaust gas, catalyst converter 14 sufficiently warmed up and changed to an active state has the ability to purify the exhaust gas, and no auxiliary means is required. Accordingly, the flow proceeds to step 113, and driving of air supplier 16 is stopped, so that introduction of air into exhaust passage 12 is stopped. In other words, at step 114, the flag H_2airflag is set to 0, and the routine is ended. When any of the decision results at steps 108, 109, or 112 is NO, the routine is immediately ended, and the next step is not implemented.

[0015]

Results (in which control results are measured for the application example) are shown in Figure 4. The abscissa indicates lapsed time, and the ordinate indicates temperature and concentration. The changes of HC concentration of the exhaust gas being discharged, catalyst bed temperature of catalyst converter 14 being detected by the temperature sensor 28, exhaust gas

temperature upstream of catalyst converter 14 (in particular, temperature upstream of the recombustion region in the vicinity of ignition plug 26), and exhaust gas temperature at the outlet of catalyst converter 14 with time is shown. The HC concentration is instantly beyond the scale range at a time of start of the internal combustion engine. However hydrogen is immediately sprayed from nozzle 24 and ignition plug 26 ignites. Thus, recombustion in exhaust passage 12 is started, and the HC concentration rapidly decreases. The time T_1, at which hydrogen is supplied, is 10 sec in the example shown in the figure. After the supply of hydrogen is stopped, HC concentration also continuously decreases, and the catalyst bed temperature and the catalyst outlet temperature are raised. The reason for this is that recombustion of exhaust gas in exhaust passage 12 continues after the stop of the supply of hydrogen, so that catalyst converter 14 is heated and activated. As a result, the exhaust purifying functioning of the catalyst converter 14 itself is rapidly increased.

[0016]

Effect of the invention

In the present invention, at the time of start of an internal combustion engine at low temperature when the catalyst converter does not have an exhaust gas purifying ability, hydrogen with excellent ignition characteristic is supplied to the exhaust passage at the upstream of the catalyst converter. Furthermore, air is supplied, and easily inflammable gases are first by the ignition plug and burned in the exhaust passage.

Thus, the combustion of HC, etc., which are unburned portions of the exhaust gas, is activated by heat, so that the contamination is removed. At the same time, the catalyst is warmed up by sending the high-temperature combustion gas to the catalyst converter, and the catalyst is rapidly activated, so that the exhaust gas purifying function intrinsic to the catalyst is exerted quickly.

[0017]

Therefore, the exhaust gas not only is purified from the start-up of the internal combustion engine, but hydrogen seldom causes a problem as a contaminant of air, even if hydrogen supplied to the exhaust passage is discharged without being ignited due to failure of the ignition plug. Thus, no pollution is likely to be caused. At any rate, according to the present invention, an internal combustion engine with an emission much lower than that of conventional internal combustion engines is obtained.

Brief description of the figures

Figure 1 is a conceptual diagram showing system constituents of the application example of the present invention.

Figure 2 is a flow chart showing a control program of the device of the present invention.

Figure 3 is a flow chart showing an initialization routine program implemented before the program of Figure 3 [sic; 2] is implemented.

Figure 4 is a line diagram showing the operation and effects of the present invention.

Explanation of symbols:

12 Exhaust passage

14 Catalytic converter

16 Air supplier

18 Hydrogen generator

20 Control valve

26 Ignition plug

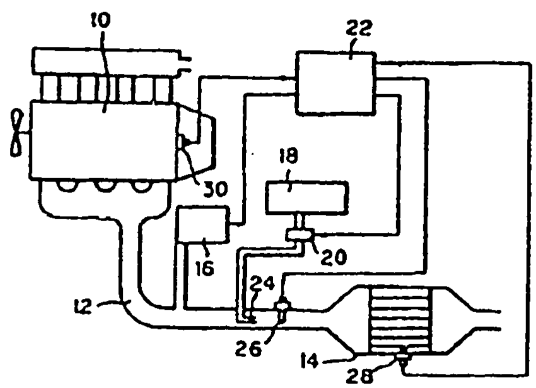

Figure 1

Key: 12 Exhaust passage
14 Catalyst converter
16 Air supplier
18 Hydrogen generator
20 Control valve
22 Control unit
24 Hydrogen nozzle
26 Ignition plug

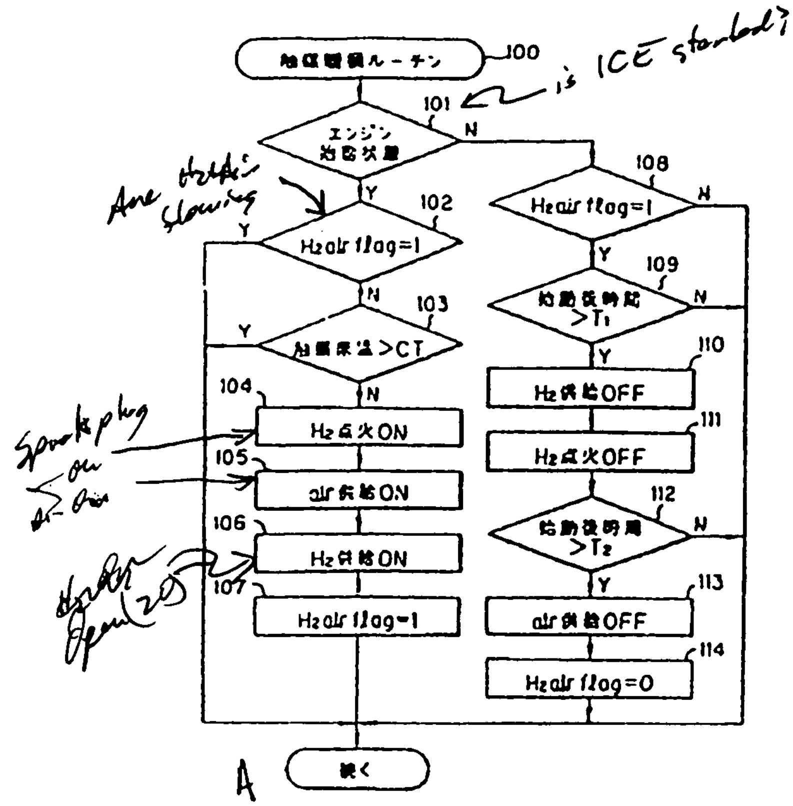

Figure 2

Key: A. Continued

- 100 Catalyst control routine
- 101 Engine start state
- 103 Catalyst bed temperature > CT
- 104 H_2 ignition ON
- 105 Air supply ON
- 106 H_2 supply ON
- 109 Time after start > T_1
- 110 H_2 supply OFF
- 111 H_2 ignition OFF
- 112 Time after start > T_2
- 113 Air supply OFF

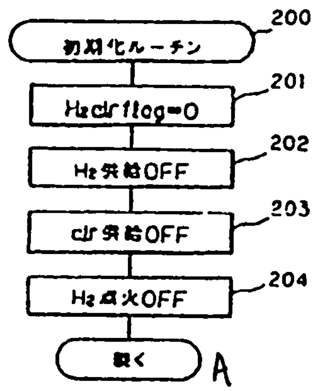

Figure 3

Key: A. Continued
200 Initialization routine
202 H_2 supply OFF
203 Air supply OFF
204 H_2 ignition OFF

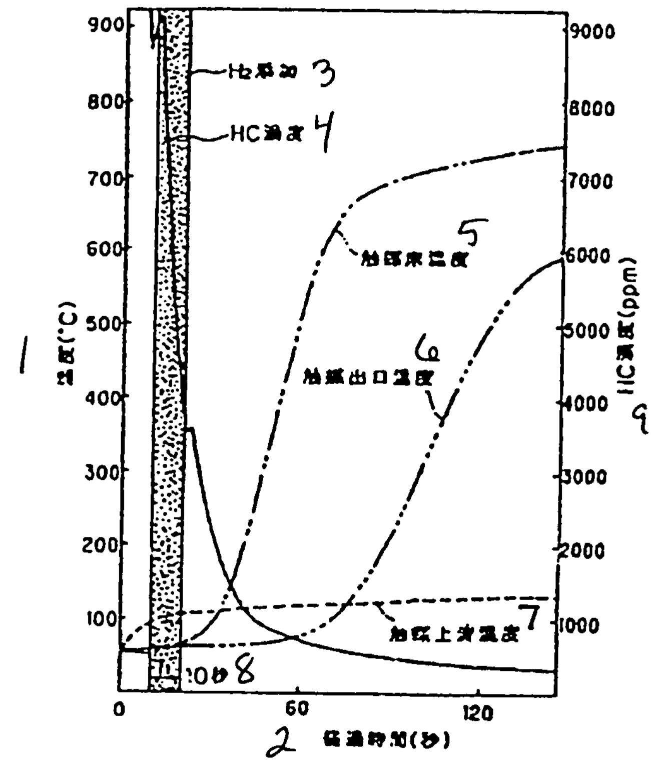

Figure 4

Key:
1 Temperature (°C)
2 Lapsed time (sec)
3 H_2 addition
4 HC concentration
5 Catalyst bed temperature
6 Catalyst outlet temperature
7 Catalyst upstream temperature
8 10 sec
9 HC concentration (ppm)